THE HOME OF THE BEES.

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THE history of the Honey-bee, of its wonderful instincts, its elaborate cells and complex economy, have engrossed the attention of the best observers, even from the time of Virgil, who sang of the Ligurian bee. The literature of the art of bee-keeping is already very extensive. Numerous bee journals and manuals of bee-keeping testify to the importance of this branch of agriculture, while able mathematicians have studied the mode of formation of the hexagonal cells,* and physiologists have investigated the intricate, and, as yet, unsolved problems of the generation and development of the bee itself.

In discussing these difficult questions, we must rise from the study of the simple to the complex, remembering that—

> "All nature widens upward. Evermore,
> The simpler essence lower lies:
> More complex is more perfect—owning more
> Discourse, more widely wise,"

and not forget to study the humbler allies of the Honey-bee. We shall, in observing the habits and homes of the wild bees, gain a clearer insight into the mysteries of the hive.

The great family of bees is divided into social and solitary species. The social kinds live in nests composed of numerous cells in which the young brood are reared. These cells vary in form from those which are quite regularly hexagonal, like those of the Hive-bee, to those which are less regularly six-sided, as in the Stingless-bee

*The cells are not perfectly hexagonal. See the studies on the formation of the cells of the bee, by Professor J. Wyman, in the "Proceedings of the American Academy of Arts and Sciences." Boston, 1866.

of the tropics (*Melipona*), until in the Humble-bee the cells are isolated and cylindrical in form.

Before speaking of the wild bees, let us briefly review the life of the Honey-bee. The queen bee having wintered over with many workers, lays her eggs in the spring, first in the worker, and, at a later period, in the drone-cells. Early in the summer the workers construct the large, flask-shaped queen-cells, which are placed on the edge of the comb, and in these the queen larvæ are fed with rich and choice food. The new queens form new swarms. The new-born queen takes her marriage flight high in the air with a drone, and on her return undertakes the management of the hive, and the duty of laying eggs. When the supply of queens is exhausted, the workers destroy the drones. The first brood of workers live about six weeks in summer, and then give way to a new brood. The queens, according to Von Berlepsch, are known to live five years, and, during their whole life, lay more than a million eggs.

In the tropics, the Honey-bee is replaced by the Meliponas and Trigonas. They are minute stingless bees, which store up honey and live in colonies often of immense extent. The cells of Melipona are hexagonal, nearly approaching in regularity those of the Hive-bee, while the honey cells are irregular, being much larger cavities which hold about one-half as much honey as a cell of the Humble-bee. "Gardner, in his travels, states that many species of Melipona build in the hollow trunks of trees, others in banks; some suspend their nests from the branches of trees, whilst one species constructs its nest of clay, it being of large size." (F. Smith.)

In a nest of *Trigona carbonaria*, from eastern Australia, Mr. F. Smith, of the British Museum, found from four

hundred to five hundred dead workers, but no females. The combs were arranged precisely similar to those of the common wasp. The number of honey-pots which were placed at the foot of the nest was two hundred and fifty. Mr. Smith inclines to the opinion that the hive of Trigona contains several prolific females, as the great number of workers can only be thus explained, and M. Guerin found six females in a nest of *Melipona fulvipes*.

At home, our nearest ally of the true Honey-bee, is the Humble-bee (*Bombus*), of which over forty species are known to inhabit North America.

The economy of the Humble-bee is thus: the queen awakens in early spring from her winter's sleep beneath the leaves or moss, or in deserted nests, and selects a nesting place generally in an abandoned nest of a field-mouse, or beneath a stump or sod, and "immediately," according to Mr. F. W. Putnam,* "collects a small amount of pollen mixed with honey, and in this deposits from seven to fourteen eggs, gradually adding to the pollen mass until the first brood is hatched. She does not wait, however, for one brood to be hatched before laying the eggs of another, but, as soon as food enough has been collected, she lays the eggs for a second. The eggs (Plate 10, Fig. 2), are laid, in contact with each other, in one cavity of the mass of pollen, with a part of which they are slightly covered. They are very soon developed; in fact the lines are nowhere distinctly drawn between the egg and the

*Notes on the Habits of the Humble-bee, Proceedings of the Essex Institute, vol. iv, 1864, p. 101. Mr. Angus thus writes us concerning the habits of *B. vagans*. "I have found the males plentiful near our garden fence, with a hole such as would be made by a mouse. They seem to be quite numerous. I was attracted to it by the noise they were making in fanning at the opening. I counted at one time as many as seven thus employed, and the sound could be heard several yards off. Several males were at rest, but mostly on the wing, when they would make a dash among the fanners, and all would scatter and sport around. The workers seem to be of a uniform size, and full as large as the males. I think the object of the fanning was to introduce air into the nest, as is done by the Honey-bees."

larva, the larva and pupa, and again between the latter and the imago; a perfect series, showing this gradual transformation of the young to the imago can be found in almost every nest.

"As soon as the larvæ are capable of motion and commence feeding, they eat the pollen by which they are surrounded, and, gradually separating, push their way in various directions. Eating as they move, and increasing in size quite rapidly, they soon make large cavities in the pollen mass. When they have attained their full size, they spin a silken wall about them, which is strengthened by the old bees covering it with a thin layer of wax, which soon becomes hard and tough, thus forming a cell. (Plate 10, Figs. 1, 2.) The larvæ now gradually attain the pupa stage, and remain inactive until their full development. They then cut their way out, and are ready to assume their duties as workers, small females, males or queens.

"It is apparent that the irregular disposition of the cells is due to their being constructed so peculiarly by the larvæ. After the first brood, composed of workers, has come forth, the queen bee devotes her time principally to her duties at home, the workers supplying the colony with honey and pollen. As the queen continues prolific, more workers are added, and the nest is rapidly enlarged.

"About the middle of summer, eggs are deposited, which produce both small females and males." . . . "All eggs laid after the last of July produce the large females, or queens, and, the males being still in the nest, it is presumed that the queens are impregnated at this time, as, on the approach of cold weather, all except the queens, of which there are several in each nest, die."

While the Humble-bee in some respects shows much less instinct than the solitary bees mentioned below, it stands higher in the series, however, from having workers, as well as males and females, who provide food for the young. The labors of the Mason-bees, and their allies, terminate after the cell is once constructed and filled with pollen. The eggs are then left to hatch, and the young care for themselves, though the adult bee shows greater skill in architecture than the Humble-bee. It is thus throughout nature. Many forms comparatively low in the scale of life astonish us with certain characters or traits, reminding us of beings much superior, physically and intellectually. The lower forms constantly reach up and in some way ally themselves with creatures far more highly organized. Thus the fish-like seal reminds us strikingly of the dog, both in the form of the head, in its docility and great intelligence when tamed, and even in its bark and the movements of the head.

The parasites of the Humble-bee are numerous. Such are the species of *Apathus*, which so closely resemble the Humble-bee itself, that it takes long study to distinguish them readily. Its habits are not known, other than that it is found in the nests of its host. It differs from the Humble-bee in having no pollen-basket, showing that its larvæ must feed on the food stored up by their host, as it does not itself collect it. The mandibles also are not, like those of Bombus, trowel-shaped for architectural purposes, but acutely triangular, and are probably not used in building.

The larvæ of various moths consume the honey and waxen cells; the two-winged flies, *Volucella* and *Conops*, and the larvæ of what is either an Anthomyia or Tachina-like fly, and several species of another genus of flies,

Anthrax, together with several beetles, such as the *Meloe*, *Stylops*, and *Antherophagus* prey upon them.

The power of boring the most symmetrical tunnels in solid wood reaches its perfection in the large Virginian Carpenter-bee (*Xylocopa Virginica*). This bee is as large, and some allied exotic species are often considerably larger than the Humble-bee, but not clothed with such dense hairs. We have received from Mr. James Angus, of West Farms, N. Y., a piece of trellis from a grape-vine, made of pine wood, containing the cells and young in various stages of growth, together with the larvæ and chrysalids of *Anthrax sinuosa*, a species of fly parasitic on the larva, which buries its head in its soft body, and feeds on its juices. (Plate 10, Fig. 5, tunnel containing pollen and young; 6, the larva; 7, the pupa, of *Anthrax sinuosa*.

Mr. Angus thus writes us regarding its habits under date of July 19: "I asked an intelligent and observing carpenter yesterday, if he knew how long it took the Xylocopa to bore her tunnel. He said he thought she bored about one-quarter of an inch a day. I don't think myself she bores more than one-half inch, if she does that. If I mistake not, it takes her about two days to make her own length at the first start; but this being across the grain of the wood may not be so easily done as the remainder, which runs parallel with it. She always follows the grain of the wood, with the exception of the entrance, which is about her own length. The tunnels run from one to one and a half feet in length. They generally run in opposite directions from the opening, and sometimes other galleries are run one above the other, using the same opening. I think they only make new tunnels when old ones are not to be found, and that the same tunnels are

used for many years. Some of the old tunnels are very wide. I have found parts of them about an inch in diameter. I think this is caused by rasping off the sides to procure the necessary material for constructing their cells. The partitions are composed of wood-raspings, and some sticky fluid, probably saliva, to make it adhere.

"The tunnels are sometimes taken possession of by other bees and wasps. I think when this is the case, the Xylocopa prefers making a new cell to cleaning out the mud and rubbish of the other species. I frequently find these bees remaining for a long time on the wing close to the opening, and bobbing their heads against the side, as if fanning air into the opening. I have seen them thus employed for twenty minutes. Whether one bee or more makes the tunnel, that is, whether they take turns in boring, I cannot say at present. In opening the cells, more than one are generally found, even at this season. About two weeks ago, I found as many as seven, I think, in one."*

The hole is divided by partitions into cells about seven-tenths of an inch long. These partitions are constructed of the coarse dust or chippings made by the bee

*"Since writing the above I have opened one of the new holes of Xylocopa which was commenced between three and four weeks ago, in a pine slat used in the staging of the greenhouse. The dimensions were as follows: Opening fully 3-8 wide; depth 7-16; whole length of tunnel 6 5-16 inches. The tunnel branched both ways from the hole. One end, from opening, was 2 5-8, containing three cells, two with larva and pollen, the third empty. The other side of the opening, or the rest of the tunnel, was empty, with the exception of the old bee (only one) at work. I think this was the work of one bee, and, as near as I can judge, about twenty-five days' work. Width of tunnel inside at widest 9-16 inch.

For some days this bee has been discharging a great quantity of saw-dust and pollen, which I had collected by placing a vessel under it. It would seem that she had cells constructed also in the opposite side of the hole, and that she removed them to enlarge the tunnel. Among the stuff thrown out, I find a partition of a cell nearly entire. I will enclose you the stuff thus collected, and also some of the first castings.

I have just found a Xylocopa bobbing at one of the holes, and in order to ascertain the depth of the tunnel, and to see whether there were any others in them, I sounded with a pliable rod, and found others in one side, at a depth of five and one half inches; the other side was four inches deep, without bees. The morning was cool, so that the object in bobbing could not be to introduce fresh currents of air, but must have had some relation to those inside. Their legs on such occasions are, as I have noticed, loaded with pollen."

in eating out her cells, for our active little carpenter is provided with strong cutting jaws, moved by powerful muscles, and on her legs are stiff brushes of hair for cleaning out the tunnel as she descends into the heart of the solid wood. She must throw out the chips she bites off from the sides of the burrow with her hind legs, passing the load of chips backwards out of the cell with her fore-limbs, which she uses as hands.

The partitions are built most elaborately of a single flattened band of chips, which is rolled up into a coil four layers deep. One side, forming the bottom of the cell, is concave, being beaten down and smoothed off by the bee. The other side of the partition, forming the top of the cell, is flat and rough.

At the time of opening the burrow, July 8th, the cells contained nearly full-grown larvæ, with some half developed. They were feeding on the masses of pollen, which were large as a thick kidney-bean, and occupied nearly half the cell. The larvæ (Plate 10, Fig. 4) resemble those of the Humble-bee, but are slenderer, tapering more rapidly towards each end of the body.

The habits and structure of the little green *Ceratina* ally it closely with Xylocopa. This pretty bee, named by Say *Ceratina dupla*, tunnels out the stems of the elder or blackberry, syringa, or any other pithy shrub, excavating them often to a depth of six or seven inches, and even, according to Mr. Haldeman (Harris MS.), bores in acorns. She makes the walls just wide enough to admit her body, and of a depth capable of holding three or four, often five or six cells (Plate 10, Fig. 11). The finely built cells, with their delicate silken walls, are cylindrical and nearly square at each end, though the free end of the last cell is rounded off. They are four and a

half tenths of an inch long, and a little over one-third as broad. The bee places them at nearly equal distances apart, the slight interval between them being filled in with dirt.

Dr. T. W. Harris* states that, May 15, 1832, one female laid its eggs in the hollow of an aster-stalk. Three perfect insects were disclosed from it July 28th. The observations of Mr. Angus, who saw some bees making their cells, May 18th, also confirms this account. The history of our little upholsterer is thus cleared up. Late in the spring she builds her cells, fills them with pollen, and lays one or more eggs upon each one. Thus in about two months the insect completes its transformations; within this period passing through the egg, the larval and chrysalid states, and then, as a bee, living a few days more, if a male; or if a female, living through the winter. Her life thus spans one year.

The larva (Plate 10, Fig. 10) is longer than that of Megachile, and compared with that of Xylocopa, the different segments are much more convex, giving a serrate outline to the back of the worm. The pupa, or chrysalis, we have found in the cells the last of July. It is white, and three-tenths of an inch long. It differs from that of the Leaf-cutter bee in having four spines on the end of the body.

In none of the wild bees are the cells constructed with more nicety than those of our little Ceratina. She bores out with her jaws a long deep well just the size of her body, and then stretches a thin delicate cloth of silk drawn tight as a drum-head across each end of her chambers, which she then fills with a mixture of pollen and honey.

*According to a note in MSS. deposited in the Library of the Boston Society of Natural History.

Her young are not, in this supposed retreat, entirely free from danger. The most invidious foes enter in and attack her young. Three species of Ichneumon-flies, two of which belong to the Chalcid family, lay their eggs within the body of the larva, and emerge from the dried larva and pupa skins of the bee, often in great numbers. The smallest parasite, belonging to the genus *Anthophorabia*, so called from being first known as a parasite on another bee, *Anthophora*, is a minute species found also abundantly in the tight cells of the Leaf-cutter bee.

The interesting habits of the Leaf-cutting, or Tailor-bee (*Megachile*), have always attracted attention. This bee is a stout, thick-bodied insect, with a large square head, stout, sharp, scissors-like jaws, and with a thick mass of stout dense hairs on the under-side of the tail for carrying pollen, as she is not provided with the pollen-basket of the Honey and Humble-bee.

The Megachile lays its eggs in burrows in the stems of the elder (Plate 10, Fig. 9), which we have received from Mr. James Angus; we have also found them in the hollows of the locust tree. Mr. F. W. Putnam thus speaks of the economy of *M. centuncularis*, our most common species. "My attention was first called, on the 26th of June, to a female busily engaged in bringing pieces of leaf to her cells, which she was building under a board, on the roof of the piazza, directly under my window. Nearly the whole morning was occupied by the bee in bringing pieces of leaf from a rose-bush growing about ten yards from her cells, returning at intervals of a half minute to a minute with the pieces which she carried in such a manner as not to impede her walking when she alighted near her hole." We give a figure of the Leaf-cutter bee in the act of cutting out a circular piece of a rose-leaf (Plate 10, Fig. 8).

She alights upon the leaf, and in a few seconds swiftly runs her scissors-like jaws around through the leaf, bearing off the piece in her hind legs. "About noon she had probably completed the cell, upon which she had been engaged, as, during the afternoon, she was occupied in bringing pollen, preparatory to laying her single egg in the cell. For about twenty days the bee continued at work, building new cells and supplying them with pollen. . . . On the 28th of July, upon removing the board, it was found that the bee had made thirty cells, arranged in nine rows of unequal length, some being slightly curved to adapt them to the space under the board. The longest row contained six cells, and was two and three-quarters inches in length; the whole leaf structure being equal to a length of fifteen inches. Upon making an estimate of the pieces of leaf in this structure, it was ascertained that there must have been at least a thousand pieces used. In addition to the labor of making the cells, this bee, unassisted in all her duties, had to collect the requisite amount of pollen (and honey?) for each cell, and lay her eggs therein, when completed. Upon carefully cutting out a portion of one of the cells, a full-grown larva was seen engaged in spinning a slight silken cocoon about the walls of its prison, which were quite hard and smooth on the inside, probably owing to the movements of the larva, and the consequent pressing of the sticky particles to the walls. In a short time the opening made was closed over by a very thin silken web. The cells, measured on the inside of the hard walls, were .35 of an inch in length, and .15 in diameter. The natural attitude of the larva is somewhat curved in its cell, but if straightened, it just equals the inside length of the cell. On the 31st of July, two female bees came out, having cut their way through the

sides of their cells." In three other cells "several hundred minute Ichneumons (*Anthophorabia megachilis*) were seen, which came forth as soon as the cells were opened."

The habits of the little blue or green Mason-bees (*Osmia*), are quite varied. They construct their cells in the stems of plants and in rotten posts and trees, or, like Andrena, they burrow in sunny banks. An European species selects snail shells for its nest, wherein it builds its earthen cells, while other species nidificate under stones. Curtis found two hundred and thirty cocoons of a British species (*Osmia paretina*), placed on the under side of a flat stone, of which one-third were empty. Of the remainder, the most appeared between March and June, males appearing first; thirty-five more bees were developed the following spring. Thus there were three successive broods, for three succeeding years, so that these bees lived three years before arriving at maturity. This may account for the *insect years*, which are like the "apple years," seasons when bees and wasps, as well as other insects, abound in unusual numbers.

Mr. G. R. Waterhouse, in the Transactions of the Entomological Society of London, for 1864 (3d series, vol. 2, p. 121), states that the cells of *Osmia leucomelana* "are formed of mud, and each cell is built separately. The female bee, having deposited a small pellet of mud in a sheltered spot between some tufts of grass, immediately commences to excavate a small cavity in its upper surface, scraping the mud away from the centre towards the margin by means of her jaws. A small shallow mud-cup is thus produced. It is rough and uneven on the outer surface, but beautifully smooth on the inner. On witnessing thus much of the work performed, I was struck

with three points. 1st, the rapidity with which the insect worked; secondly, the tenacity with which she kept her original position whilst excavating; and thirdly, her constantly going over work which had apparently been completed. . . . The lid is excavated and rendered concave on its outer or upper surface, and is convex and rough on its inner surface; and, in fact, is a simple repetition of the first-formed portion of the cell, a part of a hollow sphere."

The largest species of Osmia known to us is a very dark-blue species.* We are indebted to a lady for specimens of the bees with their cells, which had been excavated in the interior of a maple tree several inches from the bark. The bee had industriously tunnelled out this elaborate burrow (Plate 10, Fig. 12), and, in this respect, resembled the habits of the Carpenter-bee (*Xylocopa*), more closely than any other species of its genus.

The tunnel was over three inches long, and about three-tenths of an inch wide. It contracted a little in width between the cell, showing that the bee worked intelligently, and wasted no more of her energies than was absolutely necessary. The burrow contained five cells, each half an inch long, being rather short and broad, with the hinder end rounded, while the opposite end, next to the one adjoining, is cut off squarely. The cell is somewhat jug-shaped, owing to a slight constriction just behind the mouth. The material of which the cell is composed is stout, silken, parchment-like, and very smooth within. The interstices between the cells are filled in with rather coarse chippings made by the bee.

*This seems to be an undescribed species. We will call it the wood-boring Osmia (*Osmia lignivora*). It is larger than the *Osmia lignaria* of Say, being just half an inch long. The head is much shorter, and less square than in Say's species. The front of the head below the antennæ is clothed with dark hairs, but above and on the thorax with yellowish ochreous hairs. The body is deep blackish-blue, with greenish reflections.

The bee cut its way out of the cells in March, and lived for a month afterwards on a diet of honey and water. It eagerly lapped up the drops of water supplied by its keeper, to whom it soon grew accustomed, and seemed to recognize.

Our smallest and most abundant species is the little green *Osmia simillima* of Smith. It builds its little oval, somewhat urn-shaped cells against the roof of the large deserted galls of the oak-gall fly (*Diplolepis confluentus*), placing them, in this instance eleven in number, in two irregular rows, from which the mature bees issue through a hole in the gall (Plate 10, Fig. 14. From specimens communicated by Mr. F. G. Sanborn). The earthen cells, containing the tough dense cocoons, were arranged irregularly so as to fit the concave vault of the larger gall, which was about two inches in diameter. On emerging from the cell the Osmia cuts out with its powerful jaws an ovate lid, nearly as large as one side of the cell.

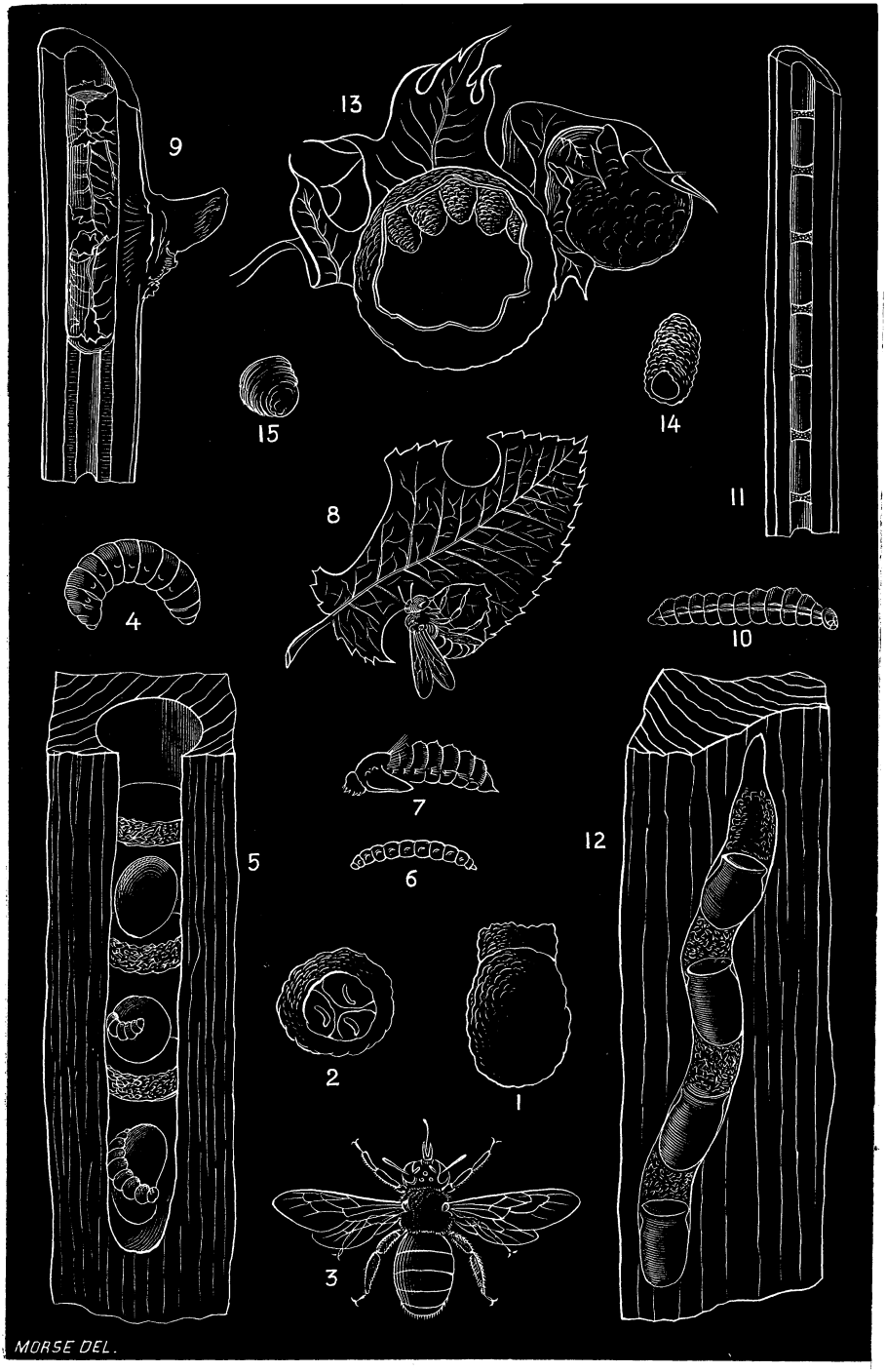
In the Harris collection are the cells and specimens of *Osmia pacifica* Say, the peaceful Osmia, which, according to the manuscript notes of Dr. Harris, is found in the perfect state in earthen cells beneath stones. The cell is oval cylindrical, a little contracted as usual with those of all the species of the genus, thus forming an urn-shaped cell. It is half an inch long, and nearly three-tenths of an inch wide, while the cocoon, which is rather thin, is three-tenths of an inch long. We are not acquainted with the habits of the larva and pupa in this country, but Mr. F. Smith states that the larva of the English species hatches in eight days after the eggs are laid, feeds ten to twelve days, when it becomes full-grown, then spins a thin silken covering, and remains in an inactive state

until the following spring, when it completes its transformations.

In the economy of our wild bees we see the manifestation of a wonderful instinct, as well as the exhibition of a *limited reason*. We can scarcely deny to animals a kind of reason which differs *only in degree* from that of man. Each species works in a sphere limited by physical laws, but within that sphere it is a free agent. They have enough of instinct and reason to direct their lives, and to enable them to act their part in carrying out the plan of creation. — *To be continued.*

EXPLANATION OF PLATE 10.

Fig. 1. A cell of the Humble-bee; natural size, with the pollen mass built upon the top.
Fig. 2. End view of the same cell, showing the three eggs laid in three divisions of the cavity.
Fig. 3. *Xylocopa Virginica*, the Carpenter Bee.
Fig. 4. The larva of *Xylocopa Virginica*, the Carpenter Bee; natural size.
Fig. 5. The nest containing the cells of the same, with the partitions and pollen masses, on which the young larva is seen in the act of feeding; natural size.
Fig. 6. Young larva of *Anthrax sinuosa*; side view.
Fig. 7. Pupa of *Anthrax sinuosa;* side view; natural size.
Fig. 8. The Leaf-cutter Bee (*Megachile*), on a rose-leaf, in the act of cutting out a circular piece.
Fig. 9. Cells of Megachile, in the elder; natural size.
Fig. 10. Larva of *Ceratina dupla*, the little green upholsterer Bee; enlarged.
Fig. 11. Cells of the same in the stem of the elder; natural size.
Fig. 12. Cells of *Osmia lignivora*, new species, the wood-devouring Mason-bee, excavated in the maple; natural size.
Fig. 13. Cells of *Osmia simillima*, the common green Mason-bee, built in the deserted gall of the Oak-gall Fly.
Fig. 14. A single earthen cell of the same; natural size.
Fig. 15. Pollen mass, or bee-bread of *Osmia lignaria;* natural size. It is made up of distinct pellets of pollen, which are probably stuck together with saliva.



PACKARD'S HOME OF THE BEES.